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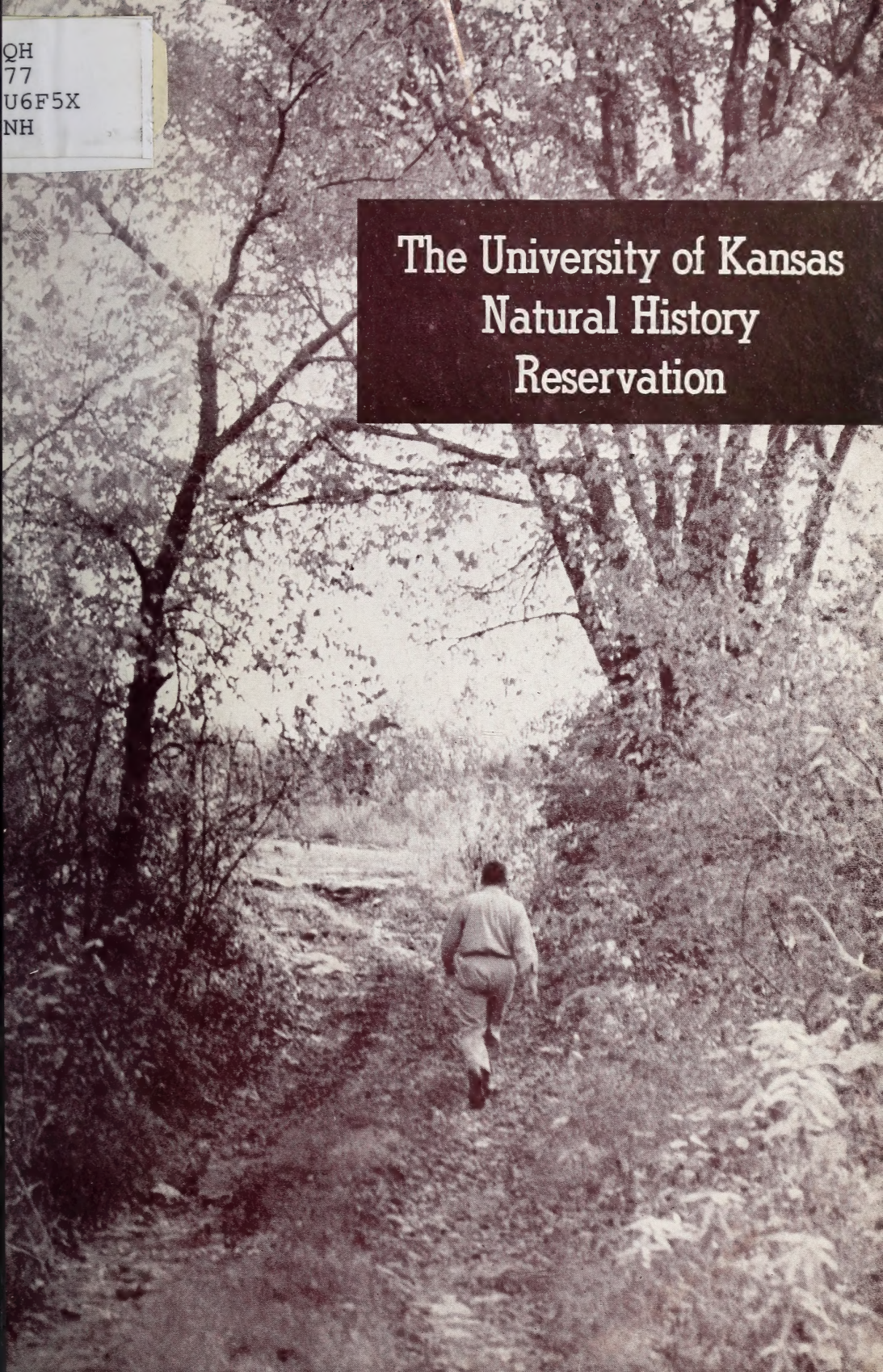
The University of Kansas Natural History Reservation



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THE UNIVERSITY OF KANSAS NATURAL HISTORY RESERVATION

BY HENRY S. FITCH

UNIVERSITY OF KANSAS
LAWRENCE · KANSAS

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MUSEUM OF NATURAL HISTORY

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The University of Kansas Natural History Reservation

BY HENRY S. FITCH

History

MORE than 1,200 acres of land in the northeast corner of the part of Douglas County, Kansas, north of the Kaw River, were willed to the University by Charles Robinson, the first governor of the state. The greater part of this area was productive farmland of the Kaw River Valley. A separate tract of some 590 acres was of comparatively little value for agricultural use, having shallow, upland soil and rocky wooded slopes. The University derived but little benefit from this latter tract, and leased it for farming and grazing, until 1948. In 1947, at the suggestion of Professor E. Raymond Hall, Chairman of the Department of Zoology, Chancellor Deane W. Malott proposed to the Board of Regents that it be set aside as a reservation where native animals and plants might be protected and studied under natural conditions. This action was taken. A small laboratory building and residence were built, and provision was made for the employment of a resident naturalist to do research on the area, and to act as caretaker, and as adviser to advanced students doing field work there. This was done with the aim of providing a place for field work in zoology and other Natural Sciences to supplement the types of study and instruction carried on in classrooms, laboratories, and museums. At other universities such natural areas already have proven their worth as outdoor laboratories for research and instruction. The Frances Simes Hastings Natural History Reservation of the University of California and the Edwin S. George Reserve of the University of Michigan are excellent examples.

The University of Kansas Natural History Reservation is situated within the broad belt of the ecotone, or transition from the eastern hardwood forests to the grasslands of the Great Plains. Its original condition is not well known, but before the coming of the white man this area probably consisted as it still does today, of mixed woodland and grassland, with each type dominating in the local situations more favorable to it. Although there are no early records

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of the flora and fauna on this particular area, there are indications that the woodland was formerly less extensive and has been expanding at the expense of adjacent grasslands, and that this change is still in progress. The writings and verbal accounts of early travellers and settlers in this part of northeastern Kansas suggest that formerly, during the last century at least, woodlands were limited mainly to the bottomlands along rivers and streams. For example, Mrs. Robinson (1899), in describing the country about Lawrence in 1855, frequently referred to the timber along the streams, and stated that the forest on the north side of the Kaw River opposite the town was two miles wide. In a few instances she mentioned the presence of trees on hilltops, but wrote nothing concerning the presence of the brush and trees now to be seen on most hillsides of this region. From her description, it appears that the slopes now wooded were mostly bare of trees and shrubs.

Development of the "climatic climax" may have been prevented by recurrent fire and heavy grazing of native ungulates. In the vicinity of Lawrence, in mid-October of 1855, Robinson (*op. cit.*, p. 304) mentions many fires burning day and night on the prairie, which looked like a "sea of flame." Uncontrolled fires, burning over large areas annually, or at less frequent intervals, might have consumed or severely scorched vegetation above ground-level, killing young trees before they became well established. Certain grasses and forbs, adapted to resist the effects of fire, can reproduce themselves quickly, from seeds or root stocks that have survived the heat. The trampling and feeding of massed herds of buffalo and other grazing mammals could kill out tree seedlings, while certain grasses and other herbs were able to survive such severe treatment and grow with renewed vigor each year. The buffalo, abundant in this region under aboriginal conditions, seems to have been eliminated early in the 19th century, as it was no longer present, or at least was not common, at the time an influx of settlers arrived in 1855, and the years immediately following.

For several centuries prior to the settlement of this general region, it was under the influence of a succession of aboriginal cultures. In part this relatively rapid succession was brought about by the progressive colonizing of European settlers fanning out from the Atlantic seaboard with resultant westward displacement of native tribes. Frequent changes in population density and varying practices in agriculture, keeping of domestic animals, hunting and burning must have had pronounced effect on the plant and animal community. Early explorers found the Kaw Indians in possession of this general region. Later it was occupied by the Delaware In-

dians, after they were given a grant of land between the Missouri and Kaw rivers by the Federal Government in 1829 and were moved from Ohio. This tribe, having attained a high cultural level through their long association with white settlers in the eastern states, lived much as did other pioneers upon arriving in Kansas territory. They built houses, sawmills and grist mills, and cultivated a variety of crops. Evidently their activities were concentrated in the main valleys of the Kaw and Missouri rivers. They were moved again, to the Indian Territory (now Oklahoma), in 1868.

The section of land adjoining the University of Kansas Natural History Reservation on the south, and the stretch of country between it and the town of Lawrence, has been described from memory by Mrs. Ward (1945) as it was in 1864 when her family moved from the town to establish a homestead. The rolling foothill land to the south of the Reservation, now under cultivation, was mainly open prairie then, with groves of blackjack oak and other trees (walnuts are mentioned) on some of the low hills.

Charles Robinson also acquired his farm in 1864. The portion which was later made a reservation was long known as the Robinson Pasture, and up to the time that it was acquired by the University was used mainly for grazing. However, four separate homesteads were made on the area. Their extent and the length of time that they were occupied cannot now be determined. They were occupied for periods of a few years, mainly in the 1870's and 1880's. A peach orchard was planted at one site. Small acreages were cultivated by the homesteaders, who also grazed livestock. Rocks and boulders were piled into walls marking the boundaries of the separate farms. Parts of these walls have been torn down and removed; the remaining parts, now in a state of collapse, are the only remaining evidence of the former farmsites. In each case the homesteader failed to profit from his small scale marginal farming operations, and eventually lost possession of the land, which reverted to pasture under control of the original owner. After the University acquired the tract, several farmers on neighboring land leased it at different times for grazing their livestock. Heavy overgrazing caused deterioration of the forage crop, originally dominated by a luxuriant cover of native grasses, to a condition in which coarse and unpalatable weeds were prominent. Severe erosion with gullying occurred. The rough and brushy hillside areas, having even less value for pasture, were fenced off from the grasslands in which livestock were kept. Some of the fences were built in the early 1940's and 1930's; others were installed earlier. With the protection thus provided, various species of trees and shrubs have thrived. No con-

scious effort was made to protect the woodland or foster its development. On the contrary, the trees most valuable or available as timber, firewood, or fence posts, have been subjected to more or less continuous harvesting. The commercially valuable walnut, hickory, and oaks have been handicapped by selective cutting, while less useful kinds, as elm, honey-shuck, and osage orange have been favored. Two small bottomland areas within peninsular extensions of the Kaw River Valley have been cultivated for corn and other crops since 1907 and 1916 respectively.

Other human activities affecting the ecology of the area include hunting, for squirrels, rabbits, raccoons, doves, and quail; trapping —mainly for raccoons, skunks, coyotes, and opossums; picnicking; and harvesting of wild crops—grapes, walnuts, and blackberries. Dogs and cats, feral or wandering from nearby farms, have been important as predators on wildlife.

The trends resulting from the cumulative effects of these factors were altered in 1948, when the area was made a reservation, protected from major disturbance by humans and domestic animals. Responses to this changed treatment were immediate and in some instances they were striking. The closely grazed pastures became covered with high grass and weeds, and at the end of the first growing season accumulated a ground litter of dead vegetation. The cover and food thereby provided has permitted the increase of small rodents from sparse to dense populations. Game animals, particularly fox squirrels and cottontails, have made notable increase since discontinuance of hunting. Other kinds of game, including white-tailed deer, and many species of wild ducks, though not permanently established as residents have used the area to an increasing extent since they have been protected there. No doubt there are many other responses as yet undetected. It may be expected that the process of change set up by protection of the area will continue for a long term of years before relatively stable conditions are finally attained.

Objectives

The objectives of the University of Kansas Natural History Reservation are: to accomplish research in ecology; to teach biology, with emphasis on natural history; and to conserve a sample of the Kansas flora and fauna. This is intended to be a permanent research station, with a long-term program of study, concerning the interrelations of native animals and plants with their physical and biotic environments, and their population dynamics under natural conditions. Continued collaborative effort by various specialists

working together on this small area will ultimately provide unusual insight into these interrelations. With the accumulation and synthesis of data over periods of years, it may be expected that the findings will prove to have unforseen practical applications. These may include: revealing certain kinds of animals as carriers and transmitters of human diseases; revealing means of "biological control" of certain undesirable species such as weeds or rodent pests; or revealing the beneficial roles of certain kinds of animals, in such effects as maintaining or restoring soil fertility.

Perhaps equally important is the educational objective. The Natural History Reservation, situated within a few minutes driving time of the University of Kansas campus at Lawrence, serves as an area where qualified students, graduates and others in the Department of Zoology and related natural sciences, may do original research in the field, with the benefit of guidance, equipment, and facilities here available. Such studies often will serve as the basis for theses in partial fulfillment of the requirements for advanced degrees. Likewise the area is available to classes in the life sciences, to observe plant and animal life under natural conditions. In the Department of Zoology the classes in Ornithology, Vertebrate Natural History, Animal Ecology, and Invertebrate Zoology have visited the area frequently.

Another function is to promote a better appreciation of the land and of living plants and animals by the public in general. The area provides practical demonstration of the benefits to be derived by protection of the land from abuse and exploitation, showing for example, the control of erosion by natural vegetation after cultivation and grazing are stopped, and gradual natural restoration of fertility and disappearance of noxious weeds after discontinuance of overgrazing.

The reference collection now being assembled, will be made as inclusive as possible for all the animals and plants of the region, and is intended to be used primarily for research. But it serves also to stimulate interest in the local fauna and flora and to familiarize interested persons with them.

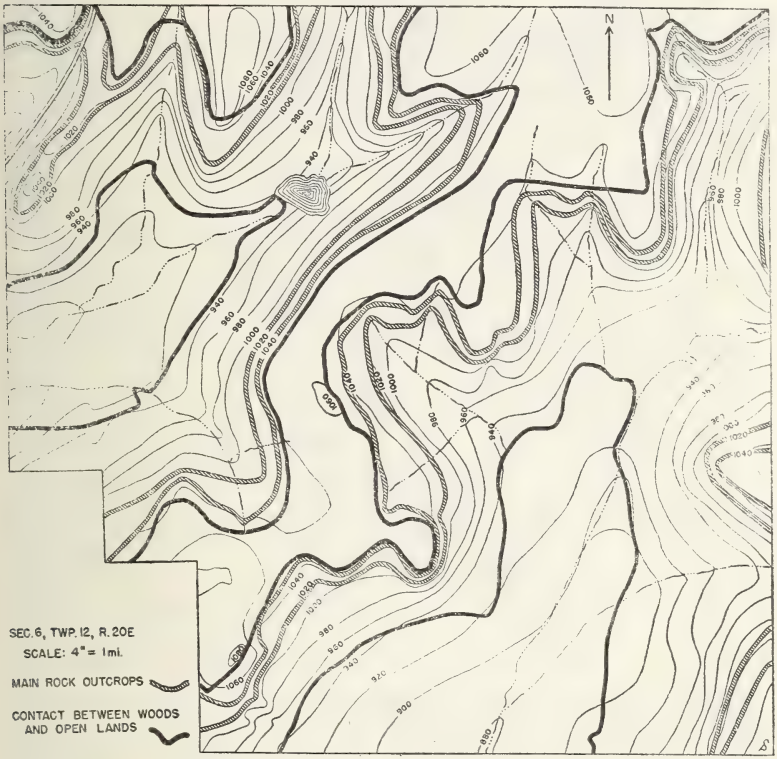
Another major objective is to provide one of the few areas within the state where native plants and animals are protected from human disturbance, and where primitive conditions are approximated, so that natural interrelations of species are revealed. The constantly increasing human population, and expanding agriculture and industry encroach everywhere except in the few such places where protection is maintained by constant effort. The animals protected on the Reservation include species of native game which propagate

naturally and attain unusually high population densities tending to disperse into depleted surrounding areas and restock them to the benefit of local sportsmen.

Description of the Area

The University of Kansas Natural History Reservation is situated on the northern edge of the Kaw River Valley, where level or gently sloping bottomland interdigitates with plateau-like upland. The "cuesta" (Schoewe, 1949, p. 282) is a prominent physiographic feature created by a stratum of limestone, nearly horizontal, approximating the 1,040-foot contour. It underlies the shallow glacial till soil of the hilltops, but with an exposed edge occurring as a more or less continuous escarpment, below which the terrain slopes, steeply at first, and then more gradually, to the level of the valley floor. The upper stratum of the cuesta is the Plattsmouth member of the Oread limestone, of late Pennsylvanian age, in the Shawnee group of the Virgilian Series (Moore, Frye and Jewett, 1944, pp. 181-182). Its exposed edge is in places almost covered and concealed by deposited soil, but for most of its length it may be seen as an outcrop from 18 inches to three feet, or in places even six feet, high or more. The face of this outcrop is deeply fissured and cracked, with numerous jagged boulders and smaller rocks, in process of breaking away or strewn over the steep slope below. Overhanging rocks of the ledge shelter the soil beneath from rain and snow, and partly shade it so that it is nearly devoid of vegetation. Many kinds of animals depend on this ledge more or less for shelter. Another member of the Oread limestone, the Toronto limestone is a conspicuously hard lower stratum at about 20 feet below the level of the hilltop and its exposed edge also occurs more or less continuously along the upper slope. Upper and lower outcrops are separated by usually 50 to 100 feet of steep wooded slope, with a soil mantle, but with quantities of loose rock. The lower outcrop often appears as a dark brown, smooth, vertical rock face, from several inches to three feet or more in height. Below this lower outcrop the hillside continues to slope steeply for a few yards, but then in most places, levels off to a natural terrace. The terrace follows the contour of the hillside and is often 30 to 50 feet wide. In places there are other terrace-like formations farther down the hillsides, and these may be nearly horizontal, or may slope gently to join the upper terrace. The upper outcrop or ledge totals approximately 4.6 miles in length on the area, and the lower outcrop approximately 4.5 miles. Below the lower outcrop the hillsides slope at more gradual gradients to the valley floor. Virtually all the

hillsides, from the cuesta top to the valley floor, and small areas of upland adjacent to the upper ledge are wooded, and this woodland comprises approximately 338 acres. The remaining 252 acres of the Reservation are open land of which about 116 acres was recently under cultivation. The open hilltop areas comprise approximately 112 acres, of which 33.5 acres were cultivated recently, 8.3 acres were undisturbed prairie, and the remaining 70 acres were weedy



UNIVERSITY OF KANSAS NATURAL HISTORY RESERVATION

Figure 1. Contour map of the University of Kansas Natural History Reservation, based upon one made by a class in the Department of Civil Engineering in 1914. The cross-hatched lines indicate the positions of the main rock outcrops. The heavy line shows the approximate position of contact between woods and open land.

pasture. The two small valleys comprise 140.5 acres of which 57.6 acres are uncultivated pastureland, while the remaining 82.9 acres, in six separate fields, were recently cultivated for corn and other crops. Each of the valleys is drained by a small creek. These creeks are intermittent, but usually some water remains in small pools along their courses, even in periods of dry weather. The creeks have eroded their channels and cut gullies through the val-

leys which they drain. The largest gully is as much as 20 feet deep and 50 feet across in places. The upland field area which was formerly cultivated, is also severely eroded by a system of gullies. In places these are as much as six feet deep. Deepest gullying has

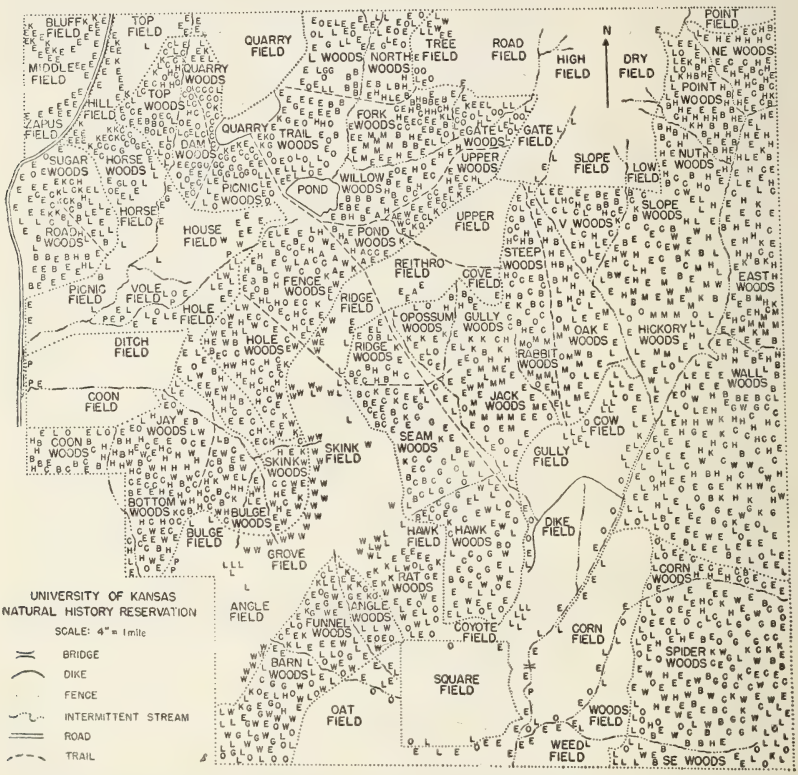


Figure 2. Map of University of Kansas Natural History Reservation showing named subdivisions of the area, and relative extent of woodland and grassland. Letter symbols indicate principal species of trees in various parts of the woodland; A—ash, B—black oak and red oak, C—yellow oak, E—elm, G—coffee tree, H—hickory, K—hackberry, L—honey-shuck, M—blackjack oak, O—osage orange, P—cottonwood, W—walnut.

occurred in the central part of the field area, and the gullies head at its upper edge. Along the lower edge of the field, run-off water deposits more soil than it erodes, because of the cuesta, with its rock outcrop relatively resistant to erosion.

Plant and Animal Life

The woodland is dominated by American elm, and the majority of large trees are of this species. Situations especially favorable to the elm are: the upper and lower rock outcrops and the steep slopes

below them; the edges of the terrace along the upper slope; and the edges of the valley bottomlands, and along small creeks crossing them. The aspect of the woodland differs markedly from place to place, according to moisture, slope exposure, and past treatment. Throughout, old decaying stumps of cut trees are frequently found. In many instances the stumps of yellow oaks and hickories have regenerated by sprouting, and given rise to new trees, now 20 feet or more in height. Along some of the hilltop edges and north slopes, there are mixed stands of large mature trees. In such situations ground vegetation is sparse and there is a heavy layer of leaf mould. On hillsides, especially the drier south facing slopes, the woodland is interspersed with many small open areas. These have a weedy vegetation, including typical prairie plants, such as big blue-stem. These small clearings perhaps represent relicts of the hillside prairie, which are being replaced by woodland. In some situations there are park-like areas along the edge of the woodland, with scattered large trees and but little shrubby vegetation. In such partially shaded situations there is usually a ground mat of drop-seed.

Three woodland hillside areas, of a few acres each, are fenced off from the remainder of the woodland and connect the hilltop and bottomland fields that were formerly grazed. The effect of trampling and grazing by livestock in keeping down the undergrowth and maintaining a relatively open woods is here well shown. Young trees and shrubby plants are scarce, in contrast with their much greater abundance on adjacent protected woodland. These hillside strips probably are most representative of the woodland as it was before stock fences separated it from the adjacent open lands used as pasture.

At the time grazing was discontinued in 1948, the wire fences constituted a sharp dividing line between the essentially herbaceous vegetation of the pastures and the woody vegetation, trees and shrubs, characteristic of the forest. Though there were a few trees scattered over the pastures, they were mostly mature ones, with trunk diameters of a foot or more, and with well-defined browse lines made by foraging livestock. Under these conditions it is obvious that hardly any reproduction of trees was occurring in the grasslands. By mid-1951, in the third growing season since discontinuance of grazing, the fence-line transition was still conspicuous, but was far less abrupt than it had been. Various species of trees and shrubs had spread to the pasture side of the fence and were progressively encroaching onto it. In the hilltop fields wild crab is prominent as a marginal invader, already forming sparse thickets three to six feet high near the edge of the woods. Intensive

winter use by cottontails, girdling many of the stems, has been insufficient to check the rapid spread of this shrub.

Throughout the grassland there is evidence of successional trend toward brush thickets and eventually woodland. An abundant crop of saplings, up to ten feet high, has sprung up. Saplings of honey-shuck are abundant. Seeds of this tree were sown over the entire area in the droppings of cattle and other animals before grazing was discontinued. Elm, osage orange, tree-of-heaven, sycamore, red haw, wild plum, and ash also are prominent as grassland invaders. The oaks, hickories and walnut have scarcely begun to invade the open areas. Lacking efficient seed dispersal mechanisms they are much slower invaders than trees with light, winged seeds.

Information concerning the kinds and numbers of trees in the woodland was obtained by counting and identifying those on sample strips 20 feet wide. Eight such strips with a total combined length of 12,865 feet and an area of 5.9 acres were sampled. Of the total sample, 78% was on hilltop edges and upper slopes, 12% on north slopes, and 10% on south slopes. Each type of situation differs somewhat in kinds, numbers, and sizes of trees, and the combined sample is not entirely representative of the entire woodland or any one part of it. Of the 1,522 trees three inches or more DBH (diameter breast high), 39.5% were elm, 17.5% hickory, 11.3% yellow oak, 8.8% red oak and black oak, 5.6% walnut, 4.9% ash, 3.7% red haw, 2.5% honey-shuck, 2.0% hackberry, 1.8% osage orange, 1.8% Kentucky coffee-tree, and .6% cherry. Of all the trees counted, 3.3% were more than two feet DBH, 14.6% were one to two feet DBH, 35.4% were six inches to one foot DBH, and 46.7% were three to six inches DBH. Of the larger trees, more than two feet DBH, 62% were elm, 20% yellow oak, 8% red oak and black oak, 4% honey-shuck, and 2% each of hickory, hackberry and walnut. Of trees one to two feet DBH, 36.9% were elm, 15.8% red oak and black oak, 10.8% yellow oak, 9.0% hickory, 7.2% walnut, 7.2% ash, 4.5% honey-shuck, 3.6% hackberry, 3.2% osage orange, and .5% each of red haw, coffee-tree, and sycamore. Of trees six inches to one foot DBH, 42.6% were elm, 13.2% were hickory, 10.2% red oak and black oak, 9.1% yellow oak, 6.1% ash, 5.6% walnut, 4.1% red haw, 3.0% honey-shuck, 2.2% osage orange, 1.9% coffee-tree, 1.6% hackberry, and .4% cherry. Of trees three inches to six inches DBH, 37.5% were elm, 23.0% hickory, 12.6% yellow oak, 5.6% red oak and black oak, 5.5% walnut, 4.6% red haw, 3.5% ash, 2.4% coffee-tree, 1.7% hackberry, 1.3% each of osage orange, honey-shuck and cherry.

Dr. W. H. Horr and Mr. R. L. McGregor have kindly furnished identifications for all the plants in the following lists. The nomen-

clature followed is that of Gray's Manual of Botany, 8th edition (Fernald, 1950).

Plants of the Woodland

Trees

Juniperaceae: *Juniperus virginiana* L. Red Cedar. A few seedlings at well scattered points through the woods; no mature trees.

Salicaceae: *Salix amygdaloides* Anderss. Peach-leaved Willow. Abundant on silty soil in vicinity of the pond, associated with other willows forming a thick grove. *Salix nigra* Marsh. Black Willow. The most abundant of the several kinds of willow growing near the pond. *Salix interior* Rowlee. Sandbar-Willow. Common, in association with the preceding species. *Salix eriocephala* Michx. Missouri Willow. Common, growing in association with other willows in damp situations near the pond. *Populus deltoides* Marsh. Cottonwood. Scarce and scattered, mainly along creeks, but also along hilltop edges; by far the largest trees of the area.

Juglandaceae: *Carya ovata* (Mill.) K. Koch. Shagbark Hickory. Abundant in much of the woodland, occurring mainly as second growth 20 to 30 feet high, in dense stands, with other hickories, and usually associated with oaks. *Carya laciniosa* (Michx.) Loud. Big Shellbark. Common, usually associated with the preceding species. *Carya glabra* (Mill.) Sweet. Pignut. Common, usually with other hickories and oaks. *Juglans nigra* L. Black Walnut. Common along upper slopes and in scattered groves along hilltop edges.

Fagaceae: *Quercus stellata* Wang. Post Oak. Localized on dry lower slopes or shoulders of hillsides, often associated with Black Jack Oak. *Quercus macrocarpa* Michx. Mossy-cup Oak. Relatively scarce, but with a few large trees, mainly on upper slopes. *Quercus Muehlenbergii* Engelm. Yellow Oak. The most abundant oak, concentrated mainly along hilltop edges, outcrops, and upper slopes. *Quercus prinoides* Willd. Chinquapin-Oak. Usually growing in association with Yellow Oak, but much scarcer. *Quercus rubra* L. Red Oak. Of scattered occurrence with some large trees, mainly along upper slopes. *Quercus velutina* Lam. Black Oak. Common; large trees usually growing in mixed stands with other oaks and hickories, along hilltop edges and north slopes. *Quercus marilandica* Munchh. Black Jack Oak. Locally abundant on several dry clay slopes.

Ulmaceae: *Ulmus rubra* Muhl. Red Elm. One of the commoner tree species, found throughout the woodland. *Ulmus americana* L. American Elm. The commonest tree of the area. *Celtis occidentalis* L. Hackberry. One of the commoner large trees, especially along rock outcrops.

Moraceae: *Morus rubra* L. Red Mulberry. Small trees are moderately common on some parts of lower slopes. *Maclura pomifera* (Raf.) Schneid. Osage orange, or "hedge." Common throughout the woodland but scattered. The fruits and seeds are important as food for certain animals, and the spiny, interlaced branches provide protection.

Platanaceae: *Platanus occidentalis* L. Sycamore. Occasional, mainly along rocky ravines in woodland.

Rosaceae: *Prunus virginiana* L. Choke-cherry. Occasional, mainly along upper slopes. *Prunus serotina* Ehrh. Black Cherry. Large trees, scarce and scattered, especially along rock outcrops. *Crataegus mollis* (T. and G.) Scheele. Red Haw. Common, often a good sized tree, both in woods and in open fields.

Leguminoseae: *Gymnocladus dioica* (L.) K. Koch. Kentucky Coffee-tree. Of sporadic occurrence, sometimes in small groves of nearly pure stands, especially on the terrace below the lower outcrop. There are scattered trees here and there in the open land of the valleys. *Gleditsia triacanthos* L. Honey-shuck. Abundant large tree throughout the woodland, and frequent in open fields, both on the hilltops and in the valleys. The formidable spines on the trunk and the branches, and in the ground litter accumulating beneath, afford shelter for many kinds of animals.

Aceraceae: *Acer saccharinum* L. Silver Maple. Occasional. *Acer Negundo* L. Box-Elder. Occasional.

Simaroubaceae: *Ailanthus altissima* (Mill.) Swingle. Tree-of-heaven. Abundant, especially in vicinity of former house sites.

Oleaceae: *Fraxinus americana* L. White Ash. Moderately common, mainly on north slopes. *Fraxinus tomentosa* Michx. Var. *subintegerrima* (Vahl) Fern. Green Ash. Localized, but abundant on certain north slopes.

Shrubs and Shrubby Trees

Anonaceae: *Asimina triloba* (L.) Dunal. Pawpaw. Uncommon.

Corylaceae: *Corylus americana* Walt. Hazel. Locally abundant, mainly in woodland edge thickets, associated with dogwood, fragrant sumac, prickly ash, and other shrubby species.

Rosaceae: *Prunus americana* Marsh. Wild Plum. Forms extensive thickets, especially on dry, rocky slopes, and along woodland edge. *Prunus angustifolia* Marsh. Chickasaw Plum. *Prunus hortulana* Bailey. Wild-goose-plum. *Prunus nana* DuRoi. Dwarf Plum. These less abundant species also grow in woodland thickets. All produce fruit which is important food for some kinds of wildlife. *Prunus persica* Batsch. Peach. Several remain at the former site of an orchard. *Pyrus ioensis* (Wood) Bailey. Wild Crab. Common, often in thickets along woodland edge. *Crataegus crus-galli* L. Cockspur-Thorn. Common, often in thickets along woodland edge. *Ribes missouriense* Nutt. Missouri Gooseberry. An abundant low shrub throughout the woodland. *Rubus argutus* Link. Blackberry. Common, in patches which often form nearly impenetrable low thickets along creeksides and woodland edges, and in small clearings on slopes. *Rubus flagellaris* Willd. Blackberry. A prostrate species, scarcer and sparser than the preceding. *Rosa setigera* Michx. Var. *tomentosa* T. and G. Prairie-Rose. Moderately common, especially along woodland edges. *Rosa arkansana* Porter Var. *suffulta* (Greene) Cockerell. Sunshine Rose. Moderately common.

Leguminoseae: *Cercis canadensis* L. Redbud. Common, a tall shrub or small tree, mainly on north slopes, and moister parts of the woods.

Anacardiaceae: *Rhus glabra* L. Smooth Sumac. Common, often forming low thickets on hilltop edges adjoining woodland, and in small clearings in the woods. *Rhus copallina* L. Var. *latifolia* Engler. Dwarf Sumac. Forms

thickets like those of the preceding species, and in similar situations, but is somewhat less abundant. *Rhus aromatica* Ait. Fragrant Sumac. Common, and especially characteristic of the upper rock outcrops, in situations where it is not heavily shaded.

Rhamnaceae: *Ceanothus americanus* L. New Jersey Tea. Scarce.

Cornaceae: *Cornus Drummondi* Meyer. Dogwood. A tall shrub or low tree with average height of perhaps ten feet, so nearly ubiquitous as to form an understory layer between the tree tops and the ground vegetation in most places. It is relatively scarce in situations where there is a dense and continuous leaf canopy twenty feet or more above the ground, but it abounds in situations where larger trees are sparse. *Cornus stolonifera* Michx. Red Osier. An understory shrub much less common than the preceding species.

Caprifoliaceae: *Symphoricarpos orbiculatus* Moench. Coralberry. An ubiquitous low shrub, forming an understory throughout most of the woods, and also common along the borders of open land. *Sambucus canadensis* L. Common Elderberry. Common, mainly at woodland edge and in creekside thickets.

Celastraceae: *Euonymus atropurpureus* Jacq. Wahoo. Occasional in thick woods.

Ebenaceae: *Diospyros virginiana* L. Persimmon. Occasional.

Rutaceae: *Xanthoxylum americanum* Mill. Prickly Ash. Common, mainly in mixed thickets along woodland edge.

Staphylaceae: *Staphylea trifolia* L. Bladdernut. Occasional.

Vines

Liliaceae: *Smilax tamnoides* L. Var. *hispida* (Muhl.) Fern. China-root. Common in woodland edge situations.

Menispermaceae: *Menispermum canadense* L. Moonseed. Common, mainly in heavily wooded areas.

Anacardiaceae: *Rhus radicans* L. Poison Ivy. Common throughout the woods.

Celastraceae: *Celastrus scandens* L. Climbing Bittersweet. Common, especially along rock outcrops of the upper slope.

Vitaceae: *Ampelopsis cordata* Michx. False Grape. Common. *Parthenocissus quinquefolia* (L.) Planch. Virginia Creeper. The most common vine, occurring throughout the woodland. *Vitis cinerea* Engelm. Graybark-Grape. Moderately common. *Vitis vulpina* L. Winter-Grape. Common throughout the woods.

Herbs

Gramineae: *Muhlenbergia Schreberi* J. F. Gmel. Drop-seed. *Muhlenbergia sylvatica* Torr. Muhly Grass. *Panicum latifolium* L. Panic-Grass.

Araceae: *Arisaema Dracontium* (L.) Schott. Green Dragon.

Cyperaceae: *Carex blanda* Dewey. Rush.

Liliaceae: *Erythronium albidum* Nutt. White Dog's-tooth-violet. *Polygonatum canaliculatum* (Muhl.) Pursh. Solomon's-seal.

Urticaceae: *Parietaria pennsylvanica* Muhl. Pellitory. *Urtica procera* Muhl. Nettle. *Laportea canadensis* (L.) Wedd. Wood-nettle.

Chenopodiaceae: *Chenopodium Boscianum* Moq. Goosefoot. *Chenopodium hybridum* L. Var. *gigantospermum* (Aellen) Rouleau. Maple-leaved Goosefoot.

Phytolaccaceae: *Phytolacca americana* L. Pokeweed.

Caryophyllaceae: *Silene stellata* (L.) Ait. Starry Campion.

Ranunculaceae: *Ranunculus abortivus* L. Buttercup. *Anemone canadense* L. Anemone. *Anemone virginiana* L. Thimbleweed. *Delphinium virescens* Nutt. Larkspur.

Cruciferae: *Arabis canadensis* L. Sicklepod. *Arabis perstellata* E. L. Br. Rock-Cress.

Podophyllaceae: *Podophyllum peltatum* L. May-apple.

Rosaceae: *Fragaria virginiana* Duchesne Var. *illinoensis* (Prince) Gray. Strawberry. *Agrimonia parviflora* Ait. Agrimony. *Agrimonia pubescens* Wallr. Agrimony. *Geum virginianum* L. Avens. *Geum vernum* (Raf.) T. and G. Avens.

Leguminoseae: *Desmodium glutinosum* (Muhl.) Wood. Tick-trefoil.

Violaceae: *Viola eriocarpa* Schw. *Viola papilionacea* Pursh. *Viola sororia* Willd. Violets.

Onagraceae: *Circaea canadensis* Hill. Enchanter's Nightshade.

Umbelliferae: *Sanicula canadensis* L. Snakeroot.

Verbenaceae: *Verbena urticifolia* L. White Vervain.

Boraginaceae: *Lappula echinata* Gilib. Stickseed.

Labiatae: *Agastache nepetoides* (L.) Kuntze. Giant Hyssop. *Prunella vulgaris* L. Var. *lanceolata* (Bart.) Fern. Heal-all. *Monarda fistulosa* L. Wild Bergamot. *Lycopus americanus* Muhl. Water-horehound.

Scrophulariaceae: *Scrophularia marilandica* L. Carpenter's-square. *Seymeria macrophylla* Nutt. Mullein-foxglove.

Acanthaceae: *Ruellia strepens* L. Ruellia.

Phrymaceae: *Phryma Leptostachya* L. Lopseed.

Caprifoliaceae: *Triosteum perfoliatum* L. Wild Coffee. *Triosteum aurantiacum* Bickn. Wild Coffee.

Plantaginaceae: *Plantago virginica* L. Hoary Plantain.

Rubiaceae: *Galium circaezans* Michx. Var. *hypomalacum* Fern. Wild Licorice. *Galium Aparine* L. Cleavers. *Galium tinctorium* L. Bedstraw.

Campanulaceae: *Campanula americana* L. Tall Bellflower. *Lobelia siphilitica* L. Great Lobelia. *Lobelia spicata* Lam. Var. *leptostachys* (A. D. C.) Mackenzie and Bush. Pale-spike Lobelia.

Compositae: *Eupatorium purpureum* L. Green-stemmed Joe-Pye Weed. *Eupatorium rugosum* Houtt. White Snakeroot. *Bidens bipinnata* L. Spanish-needle. *Lactuca floridana* (L.) Gaertner. Wild Lettuce. *Cacalia*

atriplicifolia L. Pale Indian-plantain. *Helenium autumnale* L. Sneezeweed. *Aster sagittifolius* Wedemeyer Var. *Drummondii* (Lindl.) Shinners. Blue Aster. *Erigeron philadelphicus* L. Fleabane.

Plants of the Grasslands and Other Open Situations

In the bottomland, the fields cultivated until recently have a weedy vegetation dominated by Giant Ragweed and Sunflower, with Velvetleaf, Aster, Horse-weed, Crabgrass, Foxtail Grass, Prickly Lettuce, Bindweed, Upright Spurge, Smartweed, Lamb's Quarters, Pigweed, and Common Ragweed. Other parts of the bottomland which were stripped of sod some years ago are dominated by Japanese Clover. Parts of hilltop fields formerly cultivated, and badly eroded, also have Japanese Clover, and much Bindweed, with Triple-awned Grass dominating in situations where erosion is worst and soil poorest. Elsewhere, both the hilltop and the bottomland have a vegetation that is a mixture of many grasses and forbs, some of them common throughout and others spotty in distribution. Ironweed and Hoary Vervain are prominent among the coarse weed species. Awnless Brome is the commonest grass, tending to dominate in most situations; Foxtail Grass, Tall Redtop Grass, Panic Grass, Bluestem Grass, Indian Grass, Barnyard Grass, and Bluegrass also are common. Others of the commonest weeds are Common Ragweed, American Germander, Wild Coffee, Dandelion, Milkweeds (several species), Aster, Joe-Pye Weed, Goldenrods (several species), Crotons, Spurges, Painted-leaf, Snow-on-the-mountain, Gaura, Stenosiphon, Horse-nettle, Buffalo-bur, Nightshade, and Ground-cherry. At the old quarry, the level area of bare rock and rocky soil supports a sparse stand of Common Ragweed, Japanese Clover, and little else while the talus area bordering the flat, and just below the rock outcrop has thickets of Sweet Clover and Stickleaf. Hemp is common in the disturbed soil near the quarry. Near the margin of the pond, Hemp and Sweet Clover are also common, the latter in the moister situations. The pond is about an acre in area. It supports various aquatic, amphibious or riparian species not found elsewhere on the Reservation. At its upper end is a silt flat, with a mat of vegetation, especially Rice-Cutgrass, Dayflower, Smartweed, various sedges and rushes, and with a grove of willows of several species in its lower portion. The shallow water has abundant vegetation, with Cat-tails, Bulrush, Pondweeds, Naiad, Wapato, Water-Purslane, and Mud-Plantain. The pond is nearly filled with silt so that the water is never more than three feet deep and dries out completely in time of drought, especially in late fall. The thick stand of Cat-tails throughout most of the pond provides

shelter at times for several kinds of ducks, rails, redwing blackbirds, song sparrows, and some others.

Many of the plants listed as occurring in woodlands also are found, occasionally at least, in more open situations. Aside from these the following list includes all the species of plants definitely identified from the grasslands, pastures, roadsides and other open areas and represented by specimens in the herbarium at the Reservation. No doubt there are many other species present but not yet collected or identified.

Grasses and Forbs

Typhaceae: *Typha latifolia* L. Common Cat-tail. *Typha angustifolia* L. Narrow-leaved Cat-tail.

Zosteraceae: *Potamogeton foliosa* Raf. Pondweed. *Potamogeton nodosus* Poir. Pondweed.

Najadaceae: *Najas guadalupensis* (Spreng.) Magnus. Naiad.

Alismataceae: *Sagittaria latifolia* Willd. Wapato.

Gramineae: *Bromus purgans* L. Canada Brome. *Bromus inermis* Leyss. Awnless Brome. *Bromus japonicus* Thunb. Japanese Chess. *Glyceria striata* (Lam.) Hitchc. Fowl Meadow-grass. *Poa pratensis* L. Kentucky Bluegrass. *Dactylis glomerata* L. Orchard-Grass. *Eragrostis capillaris* (L.) Lacegrass. *Eragrostis cilianensis* (All.) Lovegrass. *Eragrostis spectabilis* (Pursh) Steud. Var. *sparsihirsuta* Farw. *Diarrhena americana* Beauv. *Triodia flava* (L.) Smyth. Tall Red-top. *Elymus virginicus* L. Terrell Grass. *Elymus virginicus* L. Var. *submuticus* Hook. Wild Rye. *Koeleria cristata* (L.) Pers. *Agrostis alba* L. Redtop. *Phleum pratense* L. Timothy. *Aristida oligantha* Michx. Triple-awned Grass. *Spartina pectinata* Link. Slough-Grass. *Bouteloua curtipendula* (Michx.) Torr. Tall Grama-Grass. *Leersia oryzoides* (L.) S W. Rice-Cutgrass. *Digitaria Ischaemum* (Schreb.) Muhl. Crabgrass. *Digitaria sanguinalis* (L.) Scop. Crabgrass. *Paspalum ciliatifolium* Michx. Var. *Stramineum* (Nash) Fern. Paspalum. *Panicum dichotomiflorum* Michx. Fall Panic Grass. *Panicum capillare* L. Old-witch Grass. *Panicum capillare* L. Var. *occidentale* Rydb. *Panicum virgatum* L. Switchgrass. *Panicum lanuginosum* Ell. Var. *septentrionale* Fern. *Panicum clandestinum* L. Panic Grass. *Echinochloa crusgalli* (L.) Beauv. Barnyard Grass. *Setaria glauca* (L.) Beauv. Foxtail. *Setaria viridis* (L.) Beauv. Green Foxtail. *Setaria Faberii* Herrm. Bristly Foxtail. *Andropogon Gerardi* Vitman. Big Bluestem. *Andropogon scoparius* Michx. Bluestem. *Andropogon virginicus* L. Broom-sedge. *Andropogon ternarius* Michx. Beardgrass. *Sorghastrum nutans* (L.) Nash. Indian Grass. *Tripsacum dactyloides* L. Eastern Gama-Grass.

Cyperaceae: *Cyperus ferruginescens* Boeckl. Umbrella-Sedge. *Scleria triglomerata* Michx. Nut-rush. *Scirpus validus* Vahl. Great Sedge. *Scirpus atrovirens* Willd. Bulrush. *Scirpus lineatus* Michx. Bulrush. *Eleocharis macrostachya* Britt. Spike-Rush. *Carex gravida* Bailey. Sedge. *Carex vulpinoidea* Michx. Sedge. *Carex Bicknellii* Britton. Sedge. *Carex brevior* (Dew.) Mack. Sedge. *Carex molesta* Mackenz. Sedge. *Carex*

hyalinolepis Steud. Sedge. *Carex Emmonsii* Dew. Sedge. *Carex annectens* Bickn. Sedge.

Commelianaceae: *Commelina communis* L. Dayflower. *Tradescantia bracteata* Small. Bracted Spiderwort.

Juncaceae: *Juncus interior* Wiegm. Rush.

Amaryllidaceae: *Hypoxis hirsuta* (L.) Coville. Stargrass.

Iridaceae: *Sisyrinchium campestre* Bickn. Blue-eyed Grass.

Cannabinaceae: *Cannabis sativa* L. Hemp.

Santalaceae: *Comandra Richardsiana* Fern. Bastard-toadflax.

Polygonaceae: *Rumex altissimus* Wood. Pale Dock. *Polygonum aviculare* L. Knotweed. *Polygonum pennsylvanicum* L. Pinkweed. *Polygonum coccineum* Muhl. Smartweed. *Polygonum lapathifolium* L. Pale Smartweed. *Polygonum Hydropiper* L. Water-pepper. *Polygonum scandens* L. Climbing False Buckwheat. *Polygonum punctatum* Ell. Water-Smartweed. *Polygonum hydropiperoides* Michx. Mild Water-pepper. *Polygonum hydropiperoides* Michx. Forma *leucocranthum* A. H. Moore.

Chenopodiaceae: *Cycloloma atriplicifolium* (Spreng.) Coult. Winged Pigweed. *Chenopodium album* L. Lamb's-quarters.

Amaranthaceae: *Amaranthus Torreyi* (Gray) Benth. Amaranth. *Amaranthus hybridus* L. Green Pigweed. *Acnida tamariscina* (Nutt.) Wood. Water-Hemp.

Nyctaginaceae: *Mirabilis nyctaginea* (Michx.) MacM. Wild Four-o'clock.

Aizoaceae: *Mollugo verticillata* L. Carpetweed.

Papaveraceae: *Corydalis flavula* (Raf.) D. C. Yellow-Harlequin.

Capparidaceae: *Polanisia trachysperma* T. and G. Clammyweed.

Cruciferae: *Capsella bursa-pastoris* (L.) Medic. Shepherd's Purse. *Thlaspi arvense* L. Penny Cress. *Erysimum repandum* L. Wallflower. *Descurainia sophia* (L.) Webb. Tansy Mustard. *Lepidium densiflorum* Schrad. Pepperwort.

Saxifragaceae: *Penthorum sedoides* L. Ditch-Stonecrop.

Rosaceae: *Potentilla simplex* Michx. Old-field-Cinquefoil. *Potentilla norvegica* L. Cinquefoil. *Geum canadense* Jacq. Var. *camporum* (Rydb.) Fern. and Weath. Avens.

Leguminoseae: *Desmanthus illinoensis* (Michx.) MacM. Prairie-Mimosa. *Cassia marilandica* L. Senna. *Cassia fasciculata* Michx. Partridge-Pea. *Baptisia leucantha* T. and G. White False Indigo. *Baptisia leucophaea* Nutt. False Indigo. *Trifolium pratense* L. White Clover. *Trifolium repens* L. Red Clover. *Melilotus officinalis* (L.) Lam. Yellow Sweet Clover. *Melilotus alba* Desr. White Sweet Clover. *Medicago lupulina* L. Yellow Trefoil. *Amorpha canescens* Pursh. Lead Plant. *Amorpha fruticosa* L. Var. *angustifolia* Pursh. Indigo-Bush. *Petalostemon candidus* (Willd.) Michx. Prairie Clover. *Psoralea esculenta* Pursh. Breadroot. *Meibomia illinoensis* (A. Gray) Kuntze. Tick-Trefoil. *Lespedeza striata* H. and A. Japanese Clover. *Lespedeza capitata* Michx. Bush Clover.

Linaceae: *Linum sulcatum* Riddell. Small Yellow Flax.

Oxalidaceae: *Oxalis violacea* L. Violet Wood-Sorrel. *Oxalis corniculata* L. Creeping Wood-Sorrel. *Oxalis europaea* Jord. Var. *Bushii* (Small) Wiegm. Wood-Sorrel.

Geraniaceae: *Geranium carolinianum* L. Carolina Cranesbill.

Euphorbiaceae: *Croton capitatus* Michx. Woolly Croton. *Croton monanthogynus* Michx. Prairie-Tea. *Acalypha virginica* L. Three-seeded Mercury. *Tragia urticifolia* Michx. Tragia. *Euphorbia missurica* Raf. Var. *intermedia* (Engelm.) L. C. Wheeler. *Euphorbia serpens* H. B. K. Creeping Spurge. *Euphorbia maculata* L. Upright Spurge. *Euphorbia dentata* Michx. Toothed Spurge. *Euphorbia heterophylla* L. Painted-Leaf. *Euphorbia marginata* Pursh. Snow-on-the-mountain. *Euphorbia corollata* L. Flowering Spurge.

Rhamnaceae: *Rhamnus lanceolata* Pursh. Buckthorn. *Ceanothus ovatus* Desf. forma *pubescens* (S. Wats.) Soper. Redroot.

Malvaceae: *Sida spinosa* L. Prickly Mallow. *Abutilon theophrasti* Medic. Velvetleaf.

Hypericaceae: *Hypericum perforatum* L. Common St. John's-wort.

Violaceae: *Viola pedatifida* G. Don. Violet. *Viola Kitaibeliana* R. and S. Var. *Rafinesquii* (Greene) Fern. Field-Pansy.

Loasaceae: *Mentzelia oligosperma* Nutt. Stickleaf.

Cactaceae: *Opuntia humifusa* Raf. Prickly Pear.

Lythraceae: *Ammannia coccinea* Rothb. Ammannia. *Lythrum alatum* Pursh. Loosestrife.

Onagraceae: *Ludwigia palustris* (L.) Ell. Water-Purslane. *Oenothera biennis* L. Evening Primrose. *Oenothera speciosa* Nutt. White Evening Primrose. *Gaura biennis* L. Biennial Gaura. *Gaura biennis* L. Var. *Pitcheri* Pickering. *Gaura parviflora* Dougl. Gaura. *Gaura parviflora* Dougl. forma *glabra* Munz. *Stenosiphon linifolius* (Nutt.) Britton. Stenosiphon.

Umbelliferae: *Osmorhiza longistylis* (Torr.) D. C. Anise-Root. *Zizia aurea* (L.) W. D. J. Koch. Golden Alexanders. *Lomatium foeniculaceum* (Nutt.) C. and R. Parsley.

Primulaceae: *Androsace occidentalis* Pursh.

Apocynaceae: *Apocynum cannabinum* L. Var. *pubescens* (Mitchell) A. D. C. Dogbane. *Apocynum cannabinum* L. Var. *glaberrimum* D. C.

Asclepiadaceae: *Asclepiodora viridis* (Walt.) Gray. Antelope-Horn. *Asclepias tuberosa* L. Pleurisy-Root. *Asclepias purpurascens* L. Purple Milkweed. *Asclepias syriaca* L. Common Milkweed. *Asclepias verticillata* L. Narrow-leaved Milkweed. *Asclepias stenophylla* Gray. Milkweed. *Ampelamus albidus* (Nutt.) Britt. Honeyvine.

Convolvulaceae: *Ipomoea hederacea* (L.) Jacq. Ivy-leaved Morning Glory. *Convolvulus arvensis* L. Field-Bindweed.

Polemoniaceae: *Phlox divaricata* L. Var. *Laphamii* Wood. Blue Phlox.

Fig. 1. Reservation Headquarters. October 13, 1951. Photo. by Robert Rose.

Fig. 2. Professor and Student Marking a Hudsonian Jumping Mouse for Release. October 13, 1951. Photo. by Robert Rose.

Fig. 1. K. U. Biology Class Studying the Home Life of Native Animals. October 13, 1951. Photo. by Robert Rose.

Fig. 2. Close-up view of one team of four students of the class shown above. October 13, 1951. Photo. by Robert Rose.

Plate III

Birds Attract Attention of Resident Naturalist. Insectivorous Birds Play an Important Role in the Economy of Kansas Land. October 13, 1951. Photo. by Robert Rose.

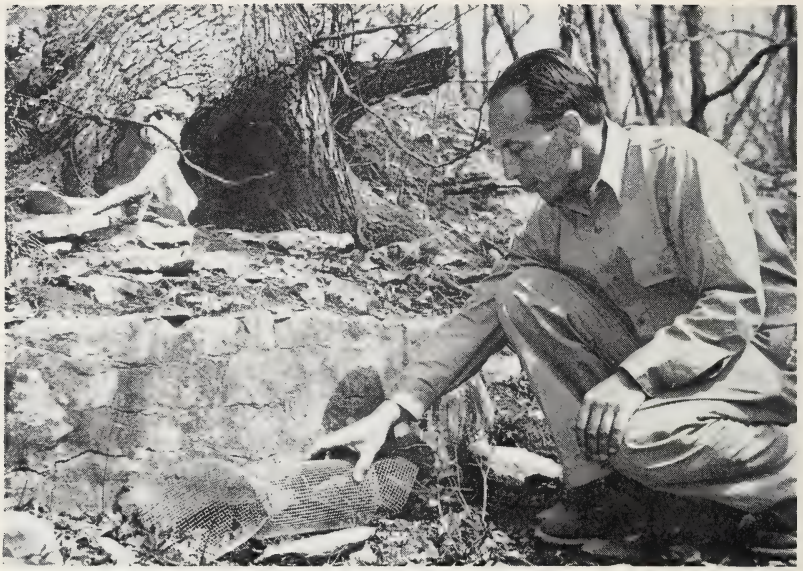


Fig. 1. Setting a Snake Trap. Early Spring, 1950. Photo. by Robert Crowley.

Fig. 2. Setting a Trap for Marsh-loving Animals. Early Spring, 1950. Photo. by Robert Crowley.

Hydrophyllaceae: *Ellisia nyctelea* L. Ellisia.

Boraginaceae: *Onosmodium occidentale* Mackenzie. False Gromwell. *Lithospermum arvense* L. Corn Gromwell. *Lithospermum incisum* Lehm. Gromwell. *Lithospermum canescens* (Michx.) Lehm. Puccoon. *Cynoglossum officinale* L. Common Hound's-tongue.

Verbenaceae: *Verbena canadensis* (L.) Britt. Rose-Vervain. *Verbena hastata* L. Blue Vervain. *Verbena stricta* Vent. forma *roseiflora* Benke. Hoary Vervain.

Labiatae: *Teucrium canadense* L. Var. *Virginica* (L.) Eat. American Germander. *Nepeta Cataria* L. Catnip. *Lamium amplexicaule* L. Dead-Nettle. *Hedeoma hispida* Pursh. Pennyroyal. *Salvia lanceolata* Willd. Sage. *Salvia azurea* Lam. Var. *grandiflora* Benth. Blue Sage. *Salvia reflexa* Hornem. Small-flowered Sage.

Solanaceae: *Solanum nigrum* L. Black Nightshade. *Solanum carolinense* L. Horse-Nettle. *Solanum rostratum* Dunal. Buffalo-Bur. *Physalis missouriensis* Mackenz. and Bush. Missouri Ground-Cherry. *Physalis longifolia* Nutt. Ground-Cherry. *Physalis pumila* Nutt. Low Ground-Cherry. *Physalis heterophylla* Nees. Ground-Cherry. *Physalis macrophysa* Rydb. *Datura Stramonium* L. Jimsonweed.

Scrophulariaceae: *Verbascum thapsus* L. Mullein. *Verbascum blattaria* L. Moth-Mullein. *Pentstemon Cobaea* Nutt. Beard-Tongue. *Mimulus alatus* Ait. Monkey-Flower.

Acanthaceae: *Ruellia humulis* Nutt. Var. *longiflora* (Gray) Fern. Ruellia.

Plantaginaceae: *Plantago major* L. Broad-leaved Plantain.

Campanulaceae: *Specularia perfoliata* (L.) A. D. C. Venus's Looking-glass.

Compositae: *Vernonia Baldwini* Torr. Var. *interior* (Small) Schub. Ironweed. *Eupatorium altissimum* L. Joe-Pye Weed. *Kuhnia Hitchcockii* A. Nels. False Boneset. *Kuhnia eupatorioides* L. Var. *corymbulosa* T. and G. False Boneset. *Liatris aspera* Michx. Blazing Star. *Liatris squarrosa* (L.) Michx. Var. *hirsuta* Rydb. Blazing Star. *Amphiachyris dracunculoides* (D. C.) Nutt. Broomweed. *Solidago nemoralis* Ait. Goldenrod. *Solidago ulmifolia* Muhl. Goldenrod. *Solidago altissima* L. Goldenrod. *Solidago rigida* L. Stiffleaf Goldenrod. *Solidago lindheimeriana* Scheele. *Aster ericoides* L. White Heath. *Aster simplex* Willd. Aster. *Erigeron canadensis* L. Horse-weed. *Erigeron strigosus* Muhl. Rough Daisy Fleabane. *Antennaria campestris* Rydb. Everlasting. *Gnaphalium obtusifolium* L. Catfoot. *Iva ciliata* Willd. Sumpweed. *Ambrosia trifida* L. Giant Ragweed. *Ambrosia artemisiifolia* L. Var. *elatior* (L.) Descourtils. Common Ragweed. *Xanthium italicum* Moretti. Cocklebur. *Silphium perfoliatum* L. Cup-Plant. *Silphium laciniatum* L. Compass-Plant. *Heliopsis helianthoides* (L.) Sweet Var. *scabra* (Dunal.) Fern. *Echinacea angustifolia* D. C. Purple Coneflower. *Ratibida pinnata* (Vent.) Barnh. Prairie-Coneflower. *Helianthus annuus* L. Common Sunflower. *Helianthus laetiflorus* Pers. Var. *rigidus* (Cass.) Fern. Sunflower. *Helianthus tuberosus* L. Jerusalem Artichoke. *Helianthus grosseserratus* Martens. Large-toothed Sunflower. *Achillea lanulosa* Nutt. Western Yarrow. *Chrysanthemum*

Leucanthemum L. White Daisy. *Lepachys pinnata* (Vent.) T. and G. Coneflower. *Cirsium discolor* (Muhl.) Spreng. Thistle. *Cirsium altissimum* (L.) Spreng. Tall Thistle. *Arctium minus* (Hill.) Bernh. Common Burdock. *Bidens frondosa* L. Beggar-Ticks. *Bidens polylepis* Blake. Bur-Marigold. *Lactuca scariola* L. Prickly Lettuce. *Lactuca canadensis* L. Var. *latifolia* Ktze. *Pyrrhopappus carolinianus* (Walt.) D. C. False Dandelion. *Prenanthes aspera* Michx. Rattlesnake-Root. *Taraxacum erythrospermum* Andrz. Red-seeded Dandelion. *Tragopon pratensis* L. Salsify.

Invertebrates

Large collections of invertebrates have been made, but relatively little of the material on hand has been identified. The only group of invertebrates studied so far are the Mollusca (Leonard, 1951). From the number of species present (23), and the abundance of some of them, it is evident that they play an important part in the over-all ecology. In many instances it is necessary to obtain the co-operation of a specialist on the family or even the genus of animals in which the identifications are desired. As one example of an invertebrate group in which a substantial beginning has been made, the spiders so far identified on the Reservation are listed below. Many of the species are extremely abundant, and in summer and fall are among the most conspicuous kinds of animals, important both as predators on invertebrates and as food for larger animals. In fields having high weeds, the large garden spiders, *Argiope aurantica* and *A. trifasciata* are so numerous that sometimes there are several of their large tough webs within a square yard. In grassy situations, especially in drop-seed muhly grass beneath trees, the ground living wolf spider, *Lycosa rabida* is present in great numbers. In woodland, webs of the arboreal *Neoscona arabesca, N. benjamina* and the smaller *Micrathena gracilis* and *Tetragnatha laboriosa* are ever present, and on the ground, especially in rocky situations, *Schizocosa saltatrix* and *Lycosa helluo* are conspicuously abundant. The writer is indebted to Dr. M. H. Muma and Dr. T. B. Kurata for the identifications.

Spiders

Agelenidae: *Agelenopsis* sp. *Cicurina ludoviciana* Simon. *Cicurina arcuata* Keys. *Cicurina lamellosa* (Keys).

Argiopidae: *Acacesia hamata* (Htz.). *Acanthepeira stellata* (Walck.). *Aranea nordmanni* (Thomas). *Aranea solitaria* (Emerton). *Argiope aurantica* Lucas. *Argiope trifasciata* (Forskal). *Cyclosa caroli* (Htz.). *Eustala anastera* (Walck.). *Leucauge venusta* (Walck.). *Mangora maculata* Keys. *Micrathena gracilis* (Walck.). *Micrathena reduviana* (Walck.). *Micrathena sagittata* (Walck.). *Neoscona arabesca* (Walck.). *Neoscona benjamina* (Walck.). *Neoscona minima* Camb. *Tetragnatha laboriosa* Htz. *Verrucosa arenata* Walck.

Attidae: *Habrocestum pulex* (Htz.). *Habronattus agilis* (Banks). *Habronattus coronatus* (Htz.). *Habronattus viridipes* (Htz.). *Maevia vittata* (Htz.). *Metaphidippus galathea* (Walck.). *Metaphidippus pretervus* (Walck.). *Marpissa undata* (De Geer). *Paraphidippus marginatus* (Walck.). *Phidippus audax* (Htz.). *Phidippus clarus* Keys. *Phidippus insignarius* Koch. *Phidippus insolens* Htz. *Phidippus pius* Scheffer. *Phidippus princeps* (Peckham). *Phidippus whitmani* Peckham.

Oxyopidae: *Oxyopes salticus* Htz.

Clubionidae: *Castianeira descripta* (Htz.). *Sergiolus capulatus* (Walck.).

Linyphiidae: *Linyphia marginata* Koch.

Lycosidae: *Evercha hoyi* (Peckham). *Geolycosa missouriensis* (Borks). *Lycosa aspera* Htz. *Lycosa carolinensis* Walck. *Lycosa gulosa* Walck. *Lycosa helluo* Walck. *Lycosa rabida* Walck. *Lycosa punctulata* Htz. *Lycosa riparia* Htz. *Pardosa lapidicina* Em. *Pirata* sp. *Schizocosa avida* (Walck.). *Schizocosa crassipes* (Walck.). *Schizocosa saltatrix* (Htz.).

Pisauridae: *Pisaurina mira* (Walck.). *Dolomedes scopularis* Koch. *Dolomedes tenebrosus* Htz. *Dolomedes scriptus* Htz.

Theridiidae: *Theridion tepidariorum* Koch. *Latrodectus mactans* Fabr.

Thomisidae: *Misumenoides* sp. *Misumenoides aleatorius* (Htz.). *Misumenops asperatus* (Htz.). *Xysticus auctifugus* Keys. *Xysticus elegans* Keys. *Xysticus ferox* (Htz.). *Xysticus funestus* Keys.

Amphibians

Ambystomidae: *Ambystoma tigrinum* (Green). Tiger Salamander. One record.

Bufonidae: *Bufo terrestris* Holbrook. American Toad. Abundant, breeding at the pond and ranging over the entire area. *Bufo woodhousii* Girard. Garden Toad. Scarce.

Hylidae: *Acris crepitans* Baird. Cricket Frog. One of the most numerous vertebrates, swarming wherever there is permanent moisture. *Pseudacris nigrita* (Le Conte). Chorus Frog. Abundant; breeds wherever there are temporary pools. *Hyla versicolor* Le Conte. Common Tree Frog. A common woodland species.

Ranidae: *Rana catesbeiana* Shaw. Bullfrog. Numerous in vicinity of pond. *Rana pipiens* Schreber. Leopard Frog. Extremely abundant, breeding at the pond, and wandering over the entire area in wet weather.

Microhylidae: *Microhyla olivacea* (Hallowell). Narrow-mouthed Toad. Common, especially on rocky hillsides.

Reptiles

Chelydridae: *Chelydra serpentina* (Linnaeus). Snapping Turtle. Only a few individuals are present, and they remain in the vicinity of the pond.

Emyidae: *Terrapene ornata* (Agassiz). Ornate Box Turtle. Found over the entire area, but not common. *Chrysemys picta* (Schneider). Painted Turtle. One record.

Iguanidae: *Crotaphytus collaris* (Say). Collared Lizard. There is a small colony at the old rock quarry.

Scincidae: *Scincella laterale* (Say). Brown Skink. Uncommon; in oak-hickory woods. *Eumeces fasciatus* (Linnaeus). Five-lined Skink. Perhaps most numerous of all the reptiles; especially common on rocky, wooded slopes. *Eumeces septentrionalis* (Baird). Prairie Skink. Rare. *Eumeces obsoletus* (Baird and Girard). Sonoran Skink. Locally common in grassy situations along rock outcrops.

Teiidae: *Cnemidophorus sexlineatus* (Linnaeus). Six-lined Racerunner. Localized in dry situations where vegetation is sparse.

Anguidae: *Ophisaurus ventralis* (Linnaeus). Glass "Snake." Scarce; usually in grassland or near woodland edge.

Colubridae: *Carphophis amoena* (Say). Worm Snake. Abundant in woodland. *Diadophis punctatus* (Linnaeus). Eastern Ring-necked Snake. The most abundant kind of snake locally. *Coluber constrictor* Linnaeus. Blue-racer. Common in grassland, and edge situations. *Elaphe emoryi* (Baird and Girard). Rat Snake. Rare. *Elaphe obsoleta* (Say). Pilot Black Snake. Moderately common in woods. *Pituophis catenifer* (Blainville). Bull Snake. Occasional—as straggler from cultivated land. *Lampropeltis calligaster* (Harlan). Blotched King Snake. Rare. *Lampropeltis getulus* (Linnaeus). Speckled King Snake. Rare. *Lampropeltis doliata* (Linnaeus). Red King Snake. Rare. *Tantilla gracilis* Baird and Girard. Slender Tantilla. Rare. *Natrix sipedon* (Linnaeus). Common Water Snake. Only a few individuals present; limited to vicinity of the pond. *Storeria dekayi* (Holbrook). De Kay's Snake. Uncommon. *Thamnophis sirtalis* (Linnaeus). Common Garter Snake. Moderately common, occurring throughout the area.

Crotalidae: *Agkistrodon contortrix* (Linnaeus). Copperhead. Moderately common; in woodland. *Crotalus horridus* Linnaeus. Timber Rattlesnake. Uncommon, mainly along rock ledges in woodland.

Birds

The birds are much more numerous in species than all the other vertebrates of the area combined. Relatively few kinds of birds remain on the area the year round. The list of birds so far compiled is incomplete. Many kinds which do not stay on the area are seen there from time to time on migration or other wandering, and frequent additions to this group may be expected. In the following list the birds are grouped according to whether they are year round residents, regular winter visitants, regular summer visitants which breed on this area, regular migrants, which each year travel over the area or stop there briefly, and "occasional" including all those that occur on the area only irregularly, on seasonal migrations or as wanderers. For some the assignment is tentative and subject to revision as more information is accumulated. For others status may be expected to change in response to changed conditions either on

the area or elsewhere in the species' range. The list is based on sight records of the writer supplemented by those of Richard W. Fredrickson.

Residents

Odontophoridae: *Colinus virginianus* (Linnaeus). Bobwhite. Two or more coveys use parts of the area.

Columbidae: *Zenaidura macroura* (Linnaeus). Mourning Dove. Moderately common during the warmer part of the year, but rarely seen in winter.

Buteonidae: *Accipiter striatus* Vieillot. Sharp-shinned Hawk. Scarce. *Accipiter cooperii* (Bonaparte). Cooper's Hawk. Scarce. *Buteo jamaicensis* (Gmelin). Red-tailed Hawk. At least one pair is permanently resident on the area, and other individuals wander onto it frequently. *Circus cyaneus* (Linnaeus). Marsh Hawk. Present throughout the year but most common in winter.

Falconidae: *Falco sparverius* Linnaeus. Sparrow Hawk. The few individuals that use the area apparently spend most of their time beyond its boundaries.

Strigidae: *Otus asio* (Linnaeus). Screech Owl. Common; heard calling at all seasons. *Bubo virginianus* (Gmelin). Horned Owl. Abundant; several pairs stay on the area. *Strix varia* Barton. Barred Owl. At least one or two pairs on the area. *Asio otus* (Linnaeus). Long-eared Owl. Rarely seen because of secretive habits but some may be permanent residents on the area.

Picidae: *Colaptes auratus* Linnaeus. Flicker. Common at all seasons, especially in winter. *Centurus carolinus* (Linnaeus). Red-bellied Woodpecker. Common, especially in oak-hickory woods. *Dendrocopos pubescens* (Linnaeus). Downy Woodpecker. The commonest woodpecker. *Dendrocopos villosus* (Linnaeus). Hairy Woodpecker. Scarce.

Corvidae: *Cyanocitta cristata* Linnaeus. Blue-jay. Common. *Corvus brachyrhynchos* Brehm. Crow. The most conspicuous bird at all seasons.

Paridae: *Parus atricapillus* Linnaeus. Black-capped Chickadee. Abundant in woodland and along "edge"; probably outnumbers all other species of birds. *Parus bicolor* Linnaeus. Tufted Titmouse. Abundant in woodland.

Troglodytidae: *Thryothorus ludovicianus* (Latham). Carolina Wren. Moderately common.

Turdidae: *Sialia sialis* (Linnaeus). Bluebird. Moderately common. *Turdus migratorius* (Linnaeus). Robin. Common in winter; summer status uncertain.

Fringillidae: *Richmondena cardinalis* (Linnaeus). Cardinal. Abundant, especially in winter. *Spinus tristis* Linnaeus. Goldfinch. Common.

Regular Summer Visitants

Cathartidae: *Cathartes aura* (Linnaeus). Turkey Vulture. Seen frequently soaring over the area, but none is known to nest there.

Buteonidae: *Buteo platypterus* (Vieillot). Broad-winged Hawk. One or two pairs nest on the area.

Cuculidae: *Coccyzus americanus* (Linnaeus). Yellow-billed Cuckoo. One of the commoner birds in summer.

Caprimulgidae: *Caprimulgus vociferus* Wilson. Whip-poor-will. Abundant throughout the woodland. *Chordeiles minor* (Forster). Nighthawk. Scarce; may not nest on the area.

Trochilidae: *Archilochus colubris* (Linnaeus). Ruby-throated Hummingbird. Moderately common.

Apodidae: *Chaetura pelagica* (Linnaeus). Chimney Swift. Seen from time to time, but does not nest on the area.

Tyrannidae: *Tyrannus tyrannus* (Linnaeus). Eastern Kingbird. Abundant. *Myiarchus crinitus* (Linnaeus). Crested Flycatcher. Abundant. *Sayornis phoebe* (Latham). Phoebe. Several pairs stay on the area. *Contopus virens* (Linnaeus). Wood Pewee. Abundant in woodland.

Troglodytidae: *Troglodytes aedon* Vieillot. House Wren. Moderately common. *Thryomanes bewicki* (Audubon). Bewick's Wren. Moderately common.

Mimidae: *Dumetella carolinensis* (Linnaeus). Catbird. Common. *Toxostoma rufum* (Linnaeus). Brown Thrasher. Moderately common.

Turdidae: *Hylocichla mustelina* (Gmelin). Wood Thrush. Moderately common in woodland.

Sylviidae: *Polioptila caerulea* (Linnaeus). Blue-gray Gnatcatcher. Common, especially in open woodland situations.

Vireonidae: *Vireo belli* Audubon. Bell's Vireo. Common in brushy situations. *Vireo olivaceus* (Linnaeus). Red-eyed Vireo. One of the commoner woodland species.

Parulidae: *Oporornis formosus* (Wilson). Kentucky Warbler. Common in woodland. *Geothlypis trichas* (Linnaeus). Yellow-throat. Common. *Icteria virens* (Linnaeus). Long-tailed Chat. Scarce.

Icteridae: *Agelaius phoeniceus* (Linnaeus). Red-wing. Several pairs nest at the pond. Migrants cross the area in spring and fall. *Icterus spurius* (Linnaeus). Orchard Oriole. Scarce. *Icterus galbula* (Linnaeus). Baltimore Oriole. Moderately common. *Molothrus ater* (Boddaert). Cowbird. Common.

Thraupidae: *Piranga olivacea* (Gmelin). Scarlet Tanager. Scarce. *Piranga rubra* (Linnaeus). Summer Tanager. Common in woodland.

Fringillidae: *Passerina cyanea* (Linnaeus). Indigo Bunting. Common in brushy situations. *Spiza americana* (Gmelin). Dickcissel. Moderately common. *Pipilo erythrophthalmus* (Linnaeus). Red-eyed Towhee. Scarce. *Chondestes grammacus* (Say). Lark Sparrow. Moderately common. *Spizella pusilla* (Wilson). Field Sparrow. One of the most common nesting birds of the area. *Pheucticus ludovicianus* (Linnaeus). Rose-breasted Grosbeak. Moderately common.

Regular Winter Visitants

Buteonidae: *Buteo lagopus* (Pontopiddian). American Rough-legged Hawk. Rare wanderer.

Sittidae: *Sitta canadensis* Linnaeus. Red-breasted Nuthatch. Scarce.

Certhiidae: *Certhia familiaris* Bonaparte. Brown Creeper. Moderately common.

Troglodytidae: *Troglodytes troglodytes* (Linnaeus). Winter Wren. Moderately common.

Parulidae: *Dendroica coronata* (Linnaeus). Myrtle Warbler. Common.

Sylviidae: *Regulus satrapa* Lichtenstein. Golden-crowned Kinglet. Common. *Regulus calendula* (Linnaeus). Ruby-crowned Kinglet. Moderately common.

Fringillidae: *Pipilo erythrophthalmus* (Linnaeus). Arctic Towhee. Moderately common. *Junco hyemalis* (Linnaeus). Junco. The most abundant wintering bird. *Spizella arborea* (Wilson). Tree Sparrow. Exceeded in numbers only by the junco. *Zonotrichia querula* (Nuttall). Harris's Sparrow. Common. *Zonotrichia leucophrys* (Forster). White-crowned Sparrow. Common. *Zonotrichia albicollis* (Gmelin). White-throated Sparrow. Moderately common. *Melospiza melodia* (Wilson). Song Sparrow. Abundant at the pond.

Regular Migrants

Anseridae: *Branta canadensis* (Linnaeus). Canada Goose. *Chen hyperborea* (Pallas). Lesser Snow Goose. *Chen coerulescens* (Linnaeus). Blue Goose.

Sturnidae: *Sturnus vulgaris* Linnaeus. Starling.

Parulidae: *Vermivora peregrina* (Wilson). Tennessee Warbler. *Vermivora celata* (Say). Orange-crowned Warbler. *Vermivora ruficapilla* (Wilson). Nashville Warbler. *Dendroica petechia* (Linnaeus). Yellow Warbler. *Dendroica virens* (Gmelin). Black-throated Green Warbler. *Dendroica striata* (Forster). Black-poll Warbler. *Seiurus aurocapillus* (Linnaeus). Oven-bird.

Icteridae: *Euphagus carolinus* (Müller). Rusty Blackbird. *Quiscalus quiscula* (Linnaeus). Bronzed Grackle.

Fringillidae: *Melospiza lincolnii* (Audubon). Lincoln's Sparrow.

Occasional

Pelecanidae: *Pelecanus erythrorhynchos* Gmelin. White Pelican.

Ardeidae: *Ardea herodias* Linnaeus. Great Blue Heron. *Butorides virescens* (Linnaeus). Green Heron. *Nycticorax nycticorax* (Boddaert). Black-crowned Night Heron.

Anatidae: *Anas platyrhynchos* Linnaeus. Mallard. *Anas acuta* Linnaeus. Pintail. *Anas carolinensis* Gmelin. Green-winged Teal. *Anas discors* Linnaeus. Blue-winged Teal. *Spatula clypeata* (Linneaus). Shoveller.

Aythya collaris (Donovan). Ring-necked Duck. *Aythya affinis* (Eyton). Lesser Scaup Duck. *Aix sponsa* (Linnaeus). Wood Duck.

Buteonidae: *Accipiter gentilis* (Linnaeus). Goshawk. *Haliaetus leucocephalus* (Linnaeus). Bald Eagle.

Rallidae: *Rallus limicola* Vieillot. Virginia Rail. *Porzana carolina* (Linnaeus). Sora. *Fulica americana* Gmelin. Coot.

Charadriidae: *Charadrius vociferus* Linnaeus. Killdeer.

Scolopacidae: *Capella gallinago* (Linnaeus). Wilson's Snipe. *Tringa solitaria* Wilson. Solitary Sandpiper. *Totanus flavipes* (Gmelin). Lesser Yellowlegs.

Laridae: *Larus pipixcan* Wagler. Franklin's Gull.

Tytonidae: *Tyto alba* (Scopoli). Barn Owl.

Alcedinidae: *Megaceryle alcyon* Linnaeus. Belted Kingfisher.

Picidae: *Melanerpes erythrocephalus* (Linnaeus). Red-headed Woodpecker.

Tyrannidae: *Empidonax flaviventris* (Baird and Baird). Yellow-bellied Flycatcher. *Empidonax minimus* (Baird and Baird). Least Flycatcher.

Alaudidae: *Eremophila alpestris* (Linnaeus). Horned Lark.

Hirundinidae: *Riparia riparia* (Linnaeus). Bank Swallow. *Hirundo rustica* Linnaeus. Barn Swallow. *Stelgidopteryx ruficollis* Bangs. Rough-winged Swallow. *Petrochelidon pyrrhonota* (Vieillot). Cliff Swallow. *Progne subis* (Linnaeus). Purple Martin.

Sittidae: *Sitta carolinensis* Latham. White-breasted Nuthatch.

Bombycillidae: *Bombycilla cedrorum* Vieillot. Cedar Waxwing.

Turdidae: *Hylocichla ustulata* (Nuttall). Olive-backed Thrush.

Laniidae: *Lanius ludovicianus* Linnaeus. Loggerhead Shrike.

Vireonidae: *Vireo solitarius* Wilson. Blue-headed Vireo. *Vireo gilvus* Vieillot. Warbling Vireo.

Parulidae: *Mniotilta varia* (Linnaeus). Black and White Warbler. *Dendroica fusca* (Miller). Blackburnian Warbler. *Seiurus noveboracensis* (Gmelin). Northern Water Thrush. *Seiurus motacilla* (Vieillot). Louisiana Water Thrush. *Setophaga ruticilla* (Linnaeus). American Redstart.

Ploceidae: *Passer domesticus* (Linnaeus). House Sparrow.

Icteridae: *Sturnella magna* (Linnaeus). Eastern Meadowlark.

Fringillidae: *Spinus pinus* (Wilson). Pine Siskin. *Carpodacus purpureus* (Gmelin). Purple Finch. *Pooecetes gramineus* (Gmelin). Vesper Sparrow. *Passerherbulus caudacutus* (Latham). Le Conte's Sparrow. *Spizella passerina* (Bechstein). Chipping Sparrow. *Spizella pallida* (Swainson). Clay-colored Sparrow.

Mammals

Didelphiidae: *Didelphis virginiana* Kerr. Opossum. Common, mainly in woodland.

Talpidae: *Scalopus aquaticus* (Linnaeus). Mole. Common throughout.

Soricidae: *Blarina brevicauda* (Say). Short-tailed Shrew. Common throughout. *Cryptotis parva* (Say). Little Short-tailed Shrew. Common throughout.

Vespertilionidae: *Nycteris borealis* (Müller). Red Bat. Probably common; bats have been seen frequently on summer evenings, and appear to be mainly of this species.

Procyonidae: *Procyon lotor* (Linnaeus). Raccoon. Moderately common.

Mustelidae: *Spilogale interrupta* (Rafinesque). Prairie Skunk. Common, for a carnivore. *Mephitis mephitis* (Schreber). Striped Skunk. Common, for a carnivore. *Mustela frenata* Lichtenstein. Long-tailed Weasel. Occasional.

Canidae: *Canis latrans* Say. Coyote. Seen and heard occasionally; sign frequent. *Vulpes fulva* Desmarest. Red Fox. Occasional.

Felidae: *Felis catus* Linnaeus. House Cat. Frequent, either wandering from nearby farms, or in feral state; important as a predator on small vertebrates.

Sciuridae: *Sciurus carolinensis* Gmelin. Gray Squirrel. Moderately common. *Sciurus niger* Linnaeus. Fox Squirrel. Abundant throughout woods, especially where oak-hickory predominates. *Marmota monax* (Linnaeus). Woodchuck. Scarce.

Geomyidae: *Geomys bursarius* (Shaw). Pocket Gopher. Scarce; a straggler from nearby farmlands.

Zapodidae: *Zapus hudsonius* (Zimmerman). Jumping Mouse. Uncommon; in a variety of habitats, especially in high grass, and (in fall) along rock ledges.

Muridae: *Rattus norvegicus* (Erxleben). Norway Rat. Occasional. *Mus musculus* Linnaeus. House Mouse. Moderately common in grassy and weedy situations and about buildings.

Cricetidae: *Sigmodon hispidus* Say and Ord. Cotton Rat. Moderately common in weedy situations; much commoner in vicinity of cultivated land nearby. *Peromyscus leucopus* (Rafinesque). White-footed Mouse. Abundant throughout the woodland, and in edge situations. *Peromyscus maniculatus* (Wagner). Deer Mouse. Moderately common in grassland. *Neotoma floridana* (Ord). Woodrat. Moderately common along rock outcrops; formerly (1948) common throughout woodland. *Pitymys pinetorum* (Le Conte). Pine Mouse. Moderately common but spotty in distribution; in woodland edge situations. *Reithrodontomys megalotis* (Baird). Harvest Mouse. Common in grassland. *Microtus ochrogaster* Wagner. Prairie Vole. Abundant in grassland. *Ondatra zibethica* (Linnaeus). Muskrat. Occasional at the pond.

Leporidae: *Sylvilagus floridanus* (Allen). Cottontail. Abundant throughout.

Cervidae: *Odocoileus virginianus* (Boddaert). White-tailed Deer. Seen from time to time and sign seen occasionally; but probably has not yet established a breeding population.

Research

The studies that have been undertaken on the Natural History Reservation so far will constitute only a small beginning even when they have been completed. A thorough understanding of the over-all ecology will require the combined efforts of several or many persons working for long periods of years. Essential links in the progress of research are provided by outside co-operators some of whom may never have visited the area. Specialists on different groups of plants and animals provide identifications and other information which could not be obtained otherwise. As one example of such co-operation, the U. S. Public Health Service has examined dozens of cultures taken from different species of mammals on the Reservation in a search for the causative organism of histoplasmosis. This disease afflicts wild and domestic mammals as well as humans.

The resident naturalist spends the greater part of his time on research. In part, his efforts are directed toward building and maintaining the reference collection which constitutes an important tool for ecological investigations. Part of his time in the field is allotted to gathering of records which will have greatest usefulness as part of long-time projects ultimately permitting a better understanding of ecological succession, and the correlation between changes in animal populations and climatic factors. Field work also includes various shorter term studies to be completed and published as more or less separate projects. Included are investigations of several of the more common and important animal species. The studies so far have included the narrow-mouthed toad, five-lined skink, Sonoran skink, collared lizard, blue-racer, pilot black snake, copperhead, horned owl, tufted titmouse, field sparrow, cardinal, opossum, white-footed mouse, deer mouse, woodrat, pine mouse and prairie vole. Some of this field work is carried on in collaboration with graduate students and others who are following closely related and supplementary lines of investigation. Most of the persons working on the area are graduate students in the Department of Zoology. The following list includes the investigations that have been undertaken up to the present time and the names of the investigators.

Natural history of the narrow-mouthed toad, *Microhyla olivacea*. Richard E. Freiburg. (Completed as dissertation for M. A. degree, February, 1951.)

Plant succession in fallow fields. Mary F. Hall.

Natural history of the ring-necked snake, *Diadophis punctatus*. John L. Hawken.

Mollusca on the University of Kansas Natural History Reservation. A. Byron Leonard. (See Literature Cited.)

Crustacea and their ecological distribution. A. Byron Leonard.

Host-parasite relationships between reptiles and chiggers. Richard B. Loomis.

Population dynamics of the prairie vole, *Microtus ochrogaster*. Edwin P. Martin.

Trees and shrubs of the Reservation. John N. Perdew.

Natural history of the harvest mouse, *Reithrodontomys megalotis*. John C. Poole.

Natural history of the woodrat, *Neotoma floridana*. Dennis G. Rainey.

Herbaceous plants of the Reservation. George E. Reed.

Feeding habits and movements of the opossum, *Didelphis virginiana*. Lewis L. Sandidge. (Completed as dissertation for M. A. degree February, 1951.)

Systematics and life history of mites, genus *Eutrombicula*. Keith A. Wolfenbarger.

Surveys of various groups of animals to determine the identity, local distribution by habitat, relative abundance, and seasonal occurrence of the kinds present are of much value, particularly as a preliminary to more intensive work. Leonard's investigation of the Mollusca on the Reservation exemplifies this type of study, and similar surveys are much needed for almost all other groups of invertebrates. The insects, in particular, with their vast array of species are far too numerous for detailed studies of each kind. It is essential, however, that as many as possible be identified, and that the ecological roles of the more common and important ones be recognized.

One of the most valuable types of study is the ecological life history. The superficiality of some ecological studies is avoided by intensive investigation of one species. Several of the studies now in progress on the Reservation are of this type. When these and similar studies of all the commoner kinds of plants and animals have been completed, much progress will have been made toward an understanding of the area's "total ecology."

An effective method of accumulating ecological data consists of recording in the field notebook all observations as they are made, concerning the presence, numbers, and behavior of animals—either by watching the animals themselves or by studying their sign, or both. This method is especially appropriate for the Natural History Reservation, where it is desired to avoid any disturbance. Such observations may serve as the basis for life history studies, particularly for those kinds of animals that are large, diurnal, and not especially shy or elusive. However, in most modern ecological studies, mere observation is supplemented by use of special equip-

ment and instruments. Some types of study consist largely of making counts or measurements, or reading instruments in the field, and correlating the readings with observed responses.

Many of the common species of animals cannot be studied effectively by mere observing, because they are small, elusive, and difficult to see in the field. They may be nocturnal in their activities or secretive in habits. For these elusive species special methods have to be devised; live trapping on a large scale makes detailed study feasible. Animals caught in live-traps are individually marked for future recognition. After desired information such as weight,

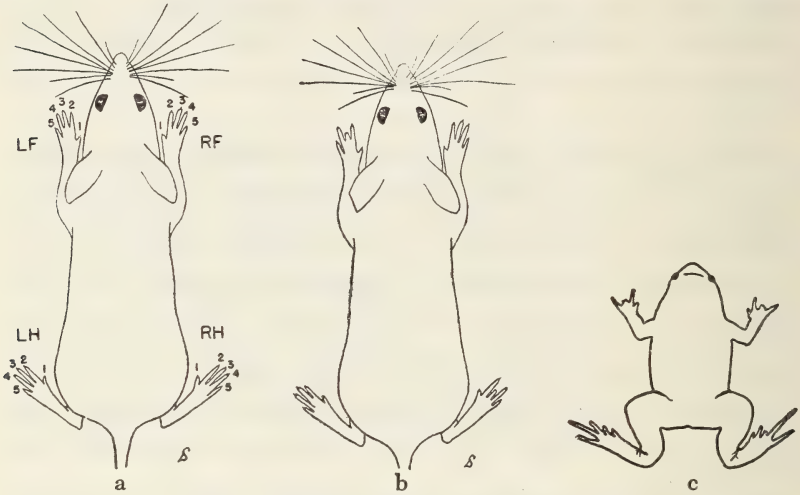


Figure 3. (a) Diagram showing letter symbols used for feet, and system of numbering toes, as a means of marking individually small mammals that are captured and released.
(b) Diagram illustrating the ear and toe formula TLE 3lf 3rh in a rodent.
(c) Diagram illustrating the toe formula 3 3 x 3 in a toad.

measurements, sex, breeding condition, parasites, and any peculiarities have been recorded, each is released as soon as possible at the point of capture. If the same individual is recaptured subsequently, comparison of the data from the two or more captures, when analyzed, may yield information concerning growth, reproduction, home range and territory, migration, feeding, and longevity. The accumulation of series of such records for many individuals may furnish much of the information needed for an understanding of the natural history of the species.

Separate record sheets are kept for each species, and entries are made in the field at the time the animals are captured. Field records are transferred to card files, having a separate card for each

individual animal with all the information concerning it available for easy comparison.

Naturally the techniques involved in catching and marking an animal vary according to the species. Birds have been caught in cage traps of standard models, and have been marked with serially numbered metal leg bands furnished by the U. S. Fish and Wildlife Service, and with colored celluloid or metal bands for sight identification. Small mammals are caught in box traps of hardware cloth wire, and are marked by a combination of ear-clipping and toe-clipping. The specimen is recorded under a formula based on the position of the clipped toes. In recording these formulas the sequence maintained for the four feet is: left front, right front, left hind, right hind. The 150 possible toe combinations (for 2 toes on different feet) are used in a regular sequence. In the "TLE" series each animal has the top of the left ear removed and when all formulas have been used, the same 150 toe combinations are used over again in combination with other ear markings, for instance "top of right ear," "front part of left ear," "hind part of left ear," etc., so that it is possible to mark many hundreds of individuals without duplicating the marks for any species. In small animals such as voles in which the minute and inconspicuous ears are not suitable for marking, three toes, and eventually four toes are used for each formula. The formula 2 3 4 x indicates the toes clipped are: second on left front foot, third on right front, fourth on left hind, with the right hind foot unclipped.

For lizards the same system of toe clipping has been used, in combination with clipped chin scales in some instances since there are no external ears to be marked. Frogs and toads have likewise been marked by toe clipping; in them the toe series is shorter, as there are only four digits on each front foot.

Snakes are marked according to the ingenious system devised by Blanchard and Finster (1933)—on each side a subcaudal scale is clipped leaving a permanent scar, and a formula is derived from the positions of the clipped scales, as counted outward from the base of the tail. Reptiles and amphibians have been trapped in large numbers in wire funnel traps set in locations where the animals are apt to wander into them. Small lizards and toads have been caught in pitfall traps, usually made of gallon cans sunk in the ground, and having the opening flush with the ground surface.

From July, 1948, to July, 1951, 5,053 individual animals of 53 species have been caught, marked, and released, with a total of 14,781 recorded captures. These marked include 4 kinds of am-

phibians, 20 kinds of reptiles, 19 kinds of mammals, and 10 kinds of birds, as listed below.

List of Animals Marked and Released on Natural History Reservation July 1, 1948, to July 1, 1951

	Number of individuals marked	Total number of captures
Common toad	6	7
Common tree toad	20	22
Swamp cricket frog	5	5
Narrow-mouthed toad	376	496
Snapping turtle	3	3
Ornate box turtle	20	26
Collared lizard	27	346
Glass-snake	11	12
Five-lined skink	970	1,361
Sonoran skink	163	501
Brown skink	7	7
Racerunner	59	148
Worm snake	80	91
Ring-necked snake	175	181
Scarlet king snake	4	4
Yellow-bellied king snake	2	2
Bullsnake	8	9
Pilot blacksnake	59	69
Blue-racer	140	170
Common water snake	5	6
Common garter snake	55	64
Dekay's snake	6	6
Copperhead	232	284
Timber rattlesnake	12	17
Horned owl	2	2
Red-bellied woodpecker	1	8
Downy woodpecker	1	1
Carolina wren	3	3
Blue-jay	6	7
Chickadee	11	15
Tufted titmouse	16	30
Cardinal	19	47
Junco	8	8
Towhee	1	3
Opossum	207	336
Short-tailed shrew	24	45
Little short-tailed shrew	2	2
Raccoon	2	2
Prairie skunk	12	19
Striped skunk	9	14
Gray squirrel	1	1
Fox squirrel	1	1
Woodchuck	1	1
Jumping mouse	4	4
House mouse	23	36
Harvest mouse	365	1,302
Cotton rat	56	217
White-footed mouse	370	1,036
Deer mouse	58	284
Woodrat	140	497
Pine mouse	67	838
Prairie vole	1,192	6,179
Cottontail	6	6

An intensive study of one species may be limited in scope to some one phase of its ecology, rather than its entire life history. Study of feeding habits often reveals some of the most important effects on, or interrelations with, ecologic associates. On the Reservation it is generally not feasible to collect stomachs in the quantities needed for food habits investigations, because this would necessitate killing of animals, and would disturb the interrelations of animal populations. But such food habits investigation based on material collected on near-by areas would have added significance when used in combination with field observations from the Natural History Reservation.

For snakes, records of food are obtained by forcing them to disgorge partly the prey that they have eaten. Feeding of hawks and owls is being investigated by collection and analysis of the pellets they have disgorged. Indigestible parts of prey such as hair, bones, and claws, or chitinized exoskeletons of insects permit accurate identification of the kinds of prey, and, sometimes, of the numbers of individual animals that have been eaten. Collection and analysis of feces, or "scats" of known origin likewise yield identifiable residue of food items, as plant fibers, seed husks, chitinized exoskeletons, bones, feathers, hair, claws, or bills. Some of the animals captured, such as snakes, turtles, lizards, or carnivorous mammals, are retained in captivity for the short time necessary to obtain scats from them, which are saved for later analysis.

Studies of the general environment also are much needed to provide a background for these more specific studies. Meteorologic records would be of value. As yet no weather station has been installed at the Reservation. Equally needed are studies of the microclimates in diverse situations, such as in rock fissures, in burrows, in dead wood, or beneath stones, in dense vegetation, on bare soil, or exposed rock.

Studies of the soil, and vegetation, as animal habitats are needed. Tracing of the progressive change in the vegetation over the whole area or selected parts of it—the course of plant succession and the parallel changes in occurrence and abundance of animals—provides one of the most fruitful fields for research. At the present time plant succession is occurring over the entire area. It is most rapid and conspicuous on the fields formerly cultivated, and is striking also on the grassland areas that were grazed until 1949. Unfortunately lack of time and facilities prevented detailed record of the changes from their outset, but during the summer and fall of 1950 Mrs. Mary F. Hall initiated a study of a fallow field area still in an

early stage of succession. The woodland areas are much more stable at the present time than the grassland areas, but presumably are progressing slowly toward a climax vegetation even though no conspicuous changes have been noticed during the two years of observation. Detailed records of the condition of woodland areas are needed to bring out the trends, and to show the effect of other factors which may appear in the future. For instance, browsing mammals may become established through natural means and may exert important effect on the understory woodland vegetation, profoundly altering the course of succession.

Still another type of study that is needed is intensive investigation of all the plants and animals of selected small areas, to determine the kinds present, and their relative abundance, both in actual numbers and in total bulk or "biomass." This would involve following seasonal trends, and working out food relationships and interdependencies.

For convenience in designating locations, the Natural History Reservation has been subdivided into more than 80 areas, each one of which is named, as shown in Fig. 2. Roads, fences, rock walls, dikes, creeks, gullies, ravines, and trails are used to delineate the boundaries. Within each one of these named areas, wherever records are taken, specific landmarks are named so that points may be located with some degree of precision. Requisites of a satisfactory landmark are that it be relatively permanent, conspicuous, and occupy such small space that it may be considered as a point rather than an area. Most of the landmarks used are trees, but boulders, and even fence posts have been utilized.

To locate a point, direction, and distance in feet from the nearest named landmark is recorded, from visual estimate, pacing, or actual measurement, depending on the degree of precision needed. For some purposes, as for example measuring the movements of small animals of sedentary habits, the usual landmarks do not suffice and it is necessary to measure off areas with markers and to make detailed maps.

Regulations

In order to ensure preservation of the fauna and flora, and to promote field studies and render the results most useful, certain regulations and restrictions have been put into effect on the Natural History Reservation. As already indicated, hunting, commercial trapping, grazing, tree-cutting, and burning are prohibited. Persons working on the area must abstain from activities which might

cause gross disturbance in the balance of the plant and animal community. No plant or animal life is to be either introduced or removed without special permission. It is especially desired to avoid unnatural mortality in the larger kinds of animals, present in relatively small numbers. However, in special cases, need for certain specimens not obtainable elsewhere may justify limited collecting. Persons doing research on the area are expected to act as wardens when occasions arise, protecting the Reservation from trespass by hunters or livestock, but at the same time attempting to maintain good public relations by tactful explanations of the reasons for the restrictions.

Field studies by qualified persons are welcome. Persons desiring to do research on the area are expected to outline the proposed study and obtain the formal approval of the resident naturalist. Field records are to be kept according to a standardized system and submitted, ultimately, for permanent filing at the Reservation. Ecological research is carried on at this reservation with the aim of publishing, ultimately, all original findings of significance. In general, publications should be limited to studies planned and outlined in advance, and miscellaneous notes should be placed on file rather than published. It is to be expected that such field notes will be of greatest value when properly synthesized in correlation with other data from the area. The publications resulting from completed research projects may often appear under joint authorship, when each participant has contributed a substantial proportion of the work involved in collecting and analyzing the data and writing the report. Persons undertaking study of problems at the Reservation, for which extensive data are already on file there, should expect to share the authorship of any resulting publications.

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